

**Planetary Surface Properties, Cratering Physics, and the Volcanic History of Mars
from a New Global Martian Crater Database**

by

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Planetary Surface Properties, Cratering Physics, and the Volcanic History of Mars from a New
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Abstract

Impact craters are arguably the primary exogenic planetary process contributing to the surface evolution of solid bodies in the solar system. Craters appear across the entire surface of Mars, and they are vital to understanding its crustal properties as well as surface ages and modification events. They allow inferences into the ancient climate and hydrologic history, and they add a key data point for the understanding of impact physics. Previously available databases of Mars impact craters were created from now antiquated datasets, automated algorithms with biases and inaccuracies, were limited in scope, and/or complete only to multi-kilometer diameters. This work presents a new global database for Mars that contains 378,540 craters statistically complete for diameters $D \geq 1$ km. This detailed database includes location and size, ejecta morphology and morphometry, interior morphology and degradation state, and whether the crater is a secondary impact. This database allowed exploration of global crater type distributions, depth, and morphologies in unprecedented detail that were used to re-examine basic crater scaling laws for the planet. The inclusion of hundreds of thousands of small, approximately kilometer-sized impacts facilitated a detailed study of the properties of nearby fields of secondary craters in relation to their primary crater. It also allowed the discovery of vast distant clusters of secondary craters over 5000 km from their primary crater, Lyot. Finally, significantly smaller craters were used to age-date volcanic calderas on the planet to re-construct the timeline of the last primary eruption events from 20 of the major Martian volcanoes.

Dedication

I dedicate this thesis to four teachers I had in middle and high school. First, Mrs. Nancy Beauregard, my sixth grade English teacher, who taught me that completing reading assignments didn't need to be a chore, and who has since become a good friend. Second are my three high school science teachers: Dr. Beverly Fennell, Mrs. Naomi Horchak-Morris, and Mr. Pat Carroll. I thank them for nurturing an interest in the natural world and science. If all teachers could be as inspiring as these four, the world would be a much better place.

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